ASPECTS OF SCALING CVD DIAMOND REACTORS

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Abstract

Diamond deposition has been a functional CVD process for over a decade but little has been done to scale deposition techniques beyond the initial small areas. The basic requirements of scaling any CVD process include maintaining temperature uniformity and reactive gas composition and distribution uniformity across the entire area of deposition. The results of this control will affect growth rate uniformity, film composition uniformity and morphology control across the deposition surface. In addition, contaminants that might affect film quality or purity must be managed effectively. Each of these must be addressed to successfully scale any process. Among the several techniques available for the synthesis of diamond films the hot filament CVD approach offered some unique advantages in terms of scalability for the deposition of diamond over large area substrates. Principle among these is that filament area can be increased without sacrificing uniformity of film deposition. Power and hence the energy required to dissociate hydrocarbons and hydrogen to generate the necessary carbon specie and atomic hydrogen required for diamond deposition scales with the size of the filament array. Local power density can be made very uniform across the entire area unlike competing technologies. In addition the relatively low power density of such tools results in easier scaling from an engineering perspective when compared with other approaches used for diamond deposition. In this paper we discuss some aspects of scaling of the hot filament CVD tool up to a square deposition area of 380mm. Examples will be presented of substrate temperature uniformity, film deposition rate uniformity, film quality and purity over 300-mm silicon wafers. Figure 1 shows an example of diamond film uniformity achieved using the hot filament CVD approach on 300mm silicon wafers. This data will then be assessed to determine the degree of improvement required to meet long term objectives for several product categories as well as any issues relating to scaling to even larger areas.

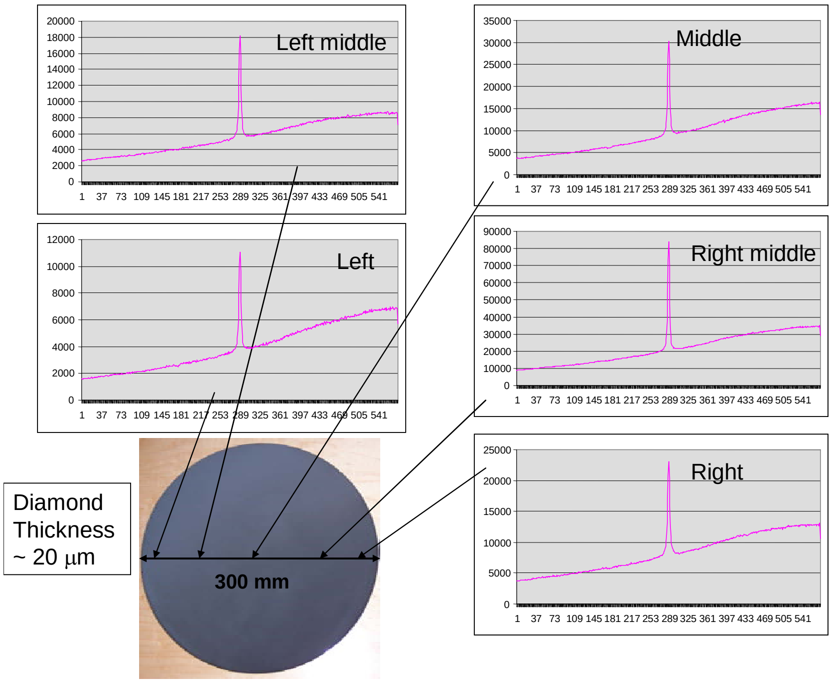

Figure1. Diamond-coated 300-mm wafer with Raman spectra at different locations of the wafer showing the film uniformity achievable with the hot filament CVD tool.